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# Recency of Pap Smear Screening: A Multivariate Model

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## Synopsis .....

*Most descriptive reports of women who have not received recent Pap smear screening have been*

*limited to bivariate descriptions. The purpose of this study was to develop a multivariate model to predict the recency of Pap smear screening. A systematic sample of women residents, aged 25 to 74 years, in upstate New York was selected. The women were asked to report use of Pap smear screening during several time periods, their congruence with recommended medical practice, general use of medical services, and a variety of socio-demographic indicators. A log linear weighted least squares regression model was developed, and it explained 30 percent of the variance in recency of Pap smear screening behavior. While the sociodemographic variables were important predictors in the model, the medical care variables were the strongest predictors of recent Pap smear use.*

*A significant relationship between race and recency of Pap smear testing was not supported by these data.*

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**T**HE PREVENTION OF THE ADVANCED STAGES of disease and death is a primary goal of cancer screening. Strong recommendations for widespread cervical cancer cytologic screening were first encouraged by the American Cancer Society in the early 1940s. Widespread adoption of this screening test had occurred by the 1950s. Although the efficacy of the Pap smear was never conclusively determined through randomized clinical trials, voluminous evidence supports it as an effective early detection technique (1-8).

It is disconcerting that, after more than 30 years of screening, cases of and deaths from invasive cervical cancer are still reported in sizable numbers each year to the New York State Cancer Registry. In upstate New York alone (New York State excluding New York City) approximately 600 new cases of invasive cervical cancer and 240 deaths are reported each year.

The ultimate evaluation of a successful effort to prevent cervical cancer is the eradication of cases and deaths from invasive disease. The National Cancer Institute's primary goal is to reduce by half the number of cancer deaths by the year 2000 (9).

Risk variables for cancer of the cervix have been identified by many investigators (10-14). These

risk variables include nonwhite women, women of low socioeconomic status, single women, and older women. In addition, women with cervical cancer are more likely to have a history of smoking, of infection with herpes simplex II virus, and of sexual debut at an early age or of multiple sexual partners. The simultaneous relationship of these variables and the use of health care variables to predict the recency of uterine cytology among women, aged 25 to 74 with an intact uterus, were explored. The instrument used was a multivariate log linear weighted least squares regression model.

## Methods

**Survey design.** For sampling the women ages 25 to 74, a list was obtained from the motor vehicle license records of the New York State Department of Motor Vehicles. The women in the sample resided in upstate New York State (exclusive of New York City), and they had renewed their driver's license within the previous year. The sample listing included the women's names, addresses, and birthdates.

In May 1984 a systematic sample, beginning with a random start, was drawn from the comput-

Table 1. Comparison of selected sociodemographic characteristics of 1984 survey respondents with 1980 census data, women ages 25-74, upstate New York (percentage distribution)

Group <sup>b</sup>	1984 survey respondents	1980 census <sup>1</sup>
Race .....	100	100
White .....	95	92
Black .....	2	6
Other .....	3	2
Education .....	100	100
8 or less years .....	3	15
9-11 years .....	8	15
12 years .....	41	41
13 or more years .....	48	30
Marital status .....	100	100
Married .....	71	54
Divorced .....	8	5
Separated .....	3	3
Widowed .....	8	13
Never married .....	10	26
Age .....	100	100
25-34 years .....	31	26
35-44 years .....	23	21
45-54 years .....	16	19
55-64 years .....	17	19
65-74 years .....	13	14

<sup>1</sup> Office of Biostatistics, New York State Department of Health, supplied age data as of September 1982.

NOTE: Percents may not add to 100 due to rounding.

erized listing of records. The selection process was executed by taking every *n*th female who met our criteria until the entire alphabetical listing of licensed drivers had been exhausted. A sample of 1,600 was desired; 1,677 were selected. A questionnaire was mailed to each woman in August 1984. A cover letter explained the objectives of the survey, and a stamped return envelope was enclosed. Followup procedures by mail were used to maximize the survey response.

Data from the 1980 census for New York State, excluding New York City, were used to determine if the age and residential characteristics of the respondents were similar to those of upstate New York residents. Possible biases due to response and coverage of the sampling frame were also evaluated.

Multiple regression analysis was performed. A log linear weighted least squares regression model was employed. The independent variables were weighted by the inverse of the covariance to stabilize the inequality of the variances.

**Pap smear history measures.** Three questions concerned the recency of a Pap smear. These were whether or not a woman had (a) ever had a Pap

smear, (b) had one within 3 years, and (c) had one within 12 months. An index was constructed to include all three Pap smear variables. If a woman had had a Pap smear in the previous 12 months, she received a score of 4. If she had had a Pap smear in the last 3 years but not in the last 12 months, she received a score of 3. If a women reported that she had ever had a Pap smear, but not in the last 3 years, she received a score of 2. If a woman had never had a Pap smear, her score was 1.

**Risk factor measures.** The respondents were asked to provide information on behavioral risk factors for cervical cancer. They were asked their age at first sexual intercourse. The data were dichotomized into less than 20 years old and 20 years and older. In addition, a binary response of "yes" or "no" was requested for the following items: whether they had had multiple (as defined by respondent) sexual partners, if they had genital herpes, whether they had ever smoked cigarettes, and whether or not they were currently smoking.

An additive index of these behavioral risk factors was constructed. All risk factors that a woman had were assigned a value of 1 and then summed. The possible range of the risk index was between 0 and 5. To summarize the risk status using the cumulative risk index, a measure was needed that would appropriately weigh the proportions falling into each category so that subgroups could be compared and the relative magnitude of the differences be addressed. For this purpose, the ridity (an acronym meaning relative to an identified distribution) was found to be very useful (15,16).

When ridity values are used as categorical weights for calculating mean levels of risk, comparison between groups is both feasible and meaningful. To calculate the ridity values, the number of respondents lower than the category in question plus one-half the number in the category in question is divided by the total number in the sample. Mathematically, this equation is expressed:

$$(n \div 2 + X) \div N$$

where *n* is the number of respondents in the category; and *X* is the cumulative number of respondents in the categories of lower values; and *N* is the sample size. The resulting value is the ridity value for that category. The mean ridity for the sample population is always .50, with values ranging from 0 to 1.0. Higher ridity values indicate higher risk status when compared to the entire sample, and lower ridity values reflect lower risk status.

**Measures for use of medical care services.** An additive index was constructed from a list of health care services to which the respondent indicated that she had made at least one visit in the last 3 years. This list included a venereal disease clinic, a birth control clinic, a colo-rectal cancer screening service, a pregnancy-related service, a physician's office for a well-visit, and a physician's office for an illness-related visit. The index also included a seventh item: whether the respondent had been hospitalized within the last year. The purpose of this index was to assess the minimum exposure that a woman had had to a variety of medical services where disrobing was likely and thus where Pap smear screening might have been appropriate.

**Medical care congruence measures.** The last factor hypothesized to have an impact on Pap smear use was compliance with recommended medical practices. Five variables were included in this index: whether the woman indicated that she had a physician or clinic for regular medical care, whether she would see a physician for any of the following conditions: a sore throat, pain, illness, or for a checkup. These five items formed a Guttman scale with a coefficient of scalability of .59 and a coefficient of reproducibility of .93.

Since hysterectomy is often considered a contraindication for Pap smear testing, the women surveyed were asked, "Have you ever had an operation to remove your uterus and/or ovaries?" The listing of responses included every possible combination of procedures. Any response that included the removal of the uterus was used to determine hysterectomy status. Women who had had a hysterectomy were excluded from the analysis.

## Results

**Survey response.** Of the 1,677 women in the sample, 68 could not be reached. More than 72 percent ( $N = 1,161$ ) of the women who were contacted completed and returned their questionnaire. Of the 1,161 respondents, 194 had had a hysterectomy. They were excluded from this analysis.

The distributions of the respondents by age and region of residence were compared to the sampling frame, the 1980 census data for the State, and the group of nonrespondents and known refusals. The age distribution of respondents was similar, within several percentage points, to women in the 1980 census data and those in the sampling frame.

Table 2. Selected behavioral characteristics of respondents with an intact uterus, ages 25-74, upstate New York, 1984

<i>Behavioral characteristic</i>	<i>Percent</i>
<b>Pap smear:</b>	
Never had .....	3
Ever had .....	97
Had within 3 years .....	82
Had within 12 months .....	60
<b>Medical care use index .....</b>	
None .....	11
1 service type .....	25
2 service types .....	40
3 service types .....	17
4 service types .....	6
5 service types .....	1
6 service types .....	1
<b>Medical congruence index .....</b>	
0 .....	100
1 .....	2
2 .....	3
3 .....	13
4 .....	19
5 .....	40
6 .....	24
<b>Risk of cervical cancer:</b>	
Early sexual debut .....	52
Multiple sex partners .....	23
Genital herpes .....	<1
Ever smoker .....	58
Current smoker .....	31

NOTE: Totals may not add to 100 due to rounding.

However, the proportion of nonrespondents (including known refusals) was slightly higher among 35-44-year-old women (29 percent compared with 23 percent of respondents) and slightly lower among women ages 65 to 74 (9 percent compared with 13 percent of respondents). Underrepresented in the sample, when compared with the census data, were black women and women with less than a high school education.

**Characteristics of the sample.** Table 1 summarizes the sociodemographic characteristics of the sample. Nearly all the respondents were white and had at least a high school education. About one-third were under 35 years. Seventy-one percent were married, 11 percent divorced or separated, and 10 percent never had married. The remaining 8 percent were widowed.

Table 2 summarizes the behavioral characteristics of the sample that are related to recency of Pap smear screening. Sixty percent had had a Pap smear within the last 12 months; 82 percent had had one within the last 3 years; and 97 percent stated that they had had at least one Pap smear test in their lifetime. Three percent of respondents had never had a Pap smear.

Table 3. Mean values for Pap smear history, by selected variables, women with an intact uterus, ages 25-74, upstate New York, 1984

Group	Percent having—		Pap smear index mean value
	Annual Pap smear	Triennial Pap smear	
Population mean . . . . .	...	...	3.3
Age:			
25-34 years . . . . .	72	92	3.6
35-44 years . . . . .	57	83	3.3
45-54 years . . . . .	53	78	3.3
55-64 years . . . . .	49	70	3.1
65-74 years . . . . .	47	67	2.9
P < . . . . .	...	...	.0001
Eta . . . . .	...	...	.25
Education:			
Less than 9 years . . . . .	32	67	2.7
9-11 years . . . . .	41	69	3.0
12 years . . . . .	53	79	3.2
13 or more years . . . . .	70	88	3.5
P < . . . . .	...	...	.0001
Eta . . . . .	...	...	.25
Race, ethnicity:			
White . . . . .	60	82	3.4
Black . . . . .	64	82	3.4
Hispanic . . . . .	70	80	3.3
Oriental . . . . .	50	83	3.2
Other . . . . .	50	70	3.2
P < . . . . .	...	...	NS
Eta . . . . .	...	...	.04
Marital status:			
Married . . . . .	60	85	3.4
Divorced . . . . .	73	87	3.6
Separated . . . . .	76	86	3.6
Widowed . . . . .	43	64	2.9
Never married . . . . .	59	75	3.2
P < . . . . .	...	...	.0001
Eta . . . . .	...	...	.18
Medical care use index:			
0 . . . . .	28	49	2.5
1 . . . . .	47	71	3.1
2 . . . . .	63	89	3.5
3 . . . . .	79	95	3.7
4 . . . . .	88	98	3.9
5 . . . . .	100	100	4.0
6 . . . . .	100	100	4.0
P < . . . . .	...	...	.0001
Eta . . . . .	...	...	.40
Medical congruence index:			
0 . . . . .	29	43	1.7
1 . . . . .	37	48	2.8
2 . . . . .	42	66	3.0
3 . . . . .	50	76	3.2
4 . . . . .	66	87	3.5
5 . . . . .	73	93	3.6
P < . . . . .	...	...	.0001
Eta . . . . .	...	...	.34
Risk of cervical cancer:			
0 . . . . .	58	78	3.3
1 . . . . .	59	83	3.4
2 . . . . .	61	85	3.5
3 . . . . .	68	88	3.6
4 . . . . .	100	100	4.0
P < . . . . .	...	...	.0001
Eta . . . . .	...	...	.11

NOTE: NS = not significant.

Use of medical services during the past 3 years ranged from 11 percent who had not been to any service during that time to a few women (less than 1 percent) who had been to six different types of services. The mean types of medical care services visited were 1.9.

Responses to the medical compliance questions showed a range from 2 percent who scored zero on the medical congruence index to 24 percent who scored 5. Three percent scored 1, 13 percent scored 2, 19 percent scored 3, and 40 percent scored 4. The mean score was 3.6.

Individual risk factors for cervical cancer are also reported in table 2. Twenty-six percent of the sample had none of these behavioral risk factors. Twenty-seven percent of the respondents had one factor, 25 percent had two factors, 16 percent had three factors, 5 percent had four, and less than 1 percent had five factors. The mean risk value of the intact uterus group was 0.51, or 2 percent higher than the sample average.

**Bivariate relationships.** Table 3 summarizes the mean values for the Pap smear history index by selected sociodemographic variables. Recency of Pap smear screening was significantly associated with age, education, and marital status. There were no significant differences by race. Divorced and separated women had the highest average scores on the recency index, and widows had the lowest. The association by age was a negative one, and age showed a significant linear relationship. Education, medical care use index, congruence index, and risk factors had positive associations with the recency of a Pap smear. All of these relationships were also linear, with medical care use and congruence indexes having the strongest linear relationships to Pap smear recency.

Table 4 describes the mean risk values on the cumulative risk index for specific demographic subgroups. No statistically significant association is noted for race at the .05 level. Risk is strongly associated with age, education, and marital status. There is a 34 percent risk differential between the youngest age group, ages 25-34, and the oldest age group, ages 65-74. Women with 9-11 years of education have a 16 percent greater differential in risk than the groups with more education, and the differential is 74 percent greater than the group with 8 years or less education.

Among the marital status categories, divorced and separated women have the highest mean risk value. Divorced women are 20 percent higher in risk than married women, and 18 percent higher

than widows. Women who are separated are 31 percent higher than married women and 28 percent higher than widowed women. Never-married women were in the middle of the spectrum. Their risk was 10 percent higher than the widowed and 12 percent higher than the married women. However, it was 16 percent lower than separated women and 7 percent lower than divorced women.

Table 5 summarizes risk by history of Pap smear and use of medical services. Women with Pap smears are more likely to be at higher risk, as are women who scored higher on the medical congruence index.

**Multivariate model.** The variables included in the multivariate model were age, marital status, education, medical care use, medical care congruence, and risk. The race variable was omitted since it was not related to recency of Pap smear in the bivariate case, and the model fit the data better when it was omitted from the equation. Several models were tested, but the model which fit the data best was a log linear equation, where all the variables were entered into the model in one step and 10 outliers were removed.

The value of  $F$  for the equation was 65.86, which was significant at  $P < .0001$ . The standardized regression coefficients are summarized in table 6. These variables explained 30 percent of the variance in the recency of Pap smear screening. The variables, use of medical services and medical congruence, were the strongest predictors in the model. Age and education made moderate contributions, and marital status and cervical cancer risk explained only a small amount of the variance.

An analysis of the residuals (the unexplained portion of the model) indicated that all assumptions, except the equality of the variances, were met. The standardized residuals followed the normal distribution, and the normal probability plots of both predictors and residuals were linear. However, the plot of the standardized residuals and the predictor values deviated from the pattern assumed for homoscedastic variance. Many transformations of the data were attempted to improve the unequal variance problem; however, none were successful. The percent of explained variance was not affected by any of these attempted transformations.

## Discussion

In most other reports, the descriptions of females who were less likely to have a Pap smear

Table 4. Risk index by selected sociodemographic characteristics using ridit analysis, upstate New York, 1984

Group	Women with an intact uterus
Population mean (risk ridit) . . . . .	.51
Age:	
25-34 years . . . . .	.55
35-44 years . . . . .	.53
45-54 years . . . . .	.50
55-64 years . . . . .	.46
65-74 years . . . . .	.41
$P <$ . . . . .	.0001
Eta . . . . .	.16
Education:	
Less than 9 years . . . . .	.34
9-11 years . . . . .	.59
12 years . . . . .	.52
13 or more years . . . . .	.50
$P <$ . . . . .	.001
Eta . . . . .	.13
Race, ethnicity:	
White . . . . .	.51
Black . . . . .	.51
Hispanic . . . . .	.54
Oriental . . . . .	.31
Other . . . . .	.49
$P <$ . . . . .	NS
Eta . . . . .	.06
Marital status:	
Married . . . . .	.49
Divorced . . . . .	.59
Separated . . . . .	.64
Widowed . . . . .	.50
Never married . . . . .	.55
$P <$ . . . . .	.001
Eta . . . . .	.14

NOTE: NS = not significant.

*Recency of Pap smear screening was significantly associated with age, education, and marital status. There were no significant differences by race. Divorced and separated women had the highest average score on the recency index, and widows the lowest.*

have been limited to bivariate descriptions (10-13). Several investigators have begun to develop multivariate models (14,17,18). The purpose of this study was to develop a multivariate model to predict the recency of Pap smear screening. A log linear weighted least squares model was used, and it fit the data well, explaining 30 percent of the variance.

Table 5. Risk index by hysterectomy status and by selected medical history characteristics using riddit analysis, upstate New York, 1984

Group	Women with an intact uterus
Population mean (risk riddit) . . . . .	.51
Pap smear ever:	
Yes . . . . .	.52
No . . . . .	.33
P < . . . . .	.0001
Pap smear in 3 years:	
Yes . . . . .	.52
No . . . . .	.46
P < . . . . .	.01
Pap smear in 12 months:	
Yes . . . . .	.52
No . . . . .	.50
P < . . . . .	NS
Medical congruence index:	
0 . . . . .	.43
1 . . . . .	.49
2 . . . . .	.54
3 . . . . .	.52
4 . . . . .	.51
5 . . . . .	.50
P < . . . . .	NS

NOTE: NS = not significant.

Table 6. Log-linear weighted least squares regression model <sup>1</sup> for recency of Pap smear screening

Variable	Beta	Standard error	Significance of t-test P <
Medical care use . . . . .	.43	.03	.0001
Medical congruence . . . . .	.27	.03	.0001
Age . . . . .	-.12	.03	.0001
Education . . . . .	.19	.03	.0001
Marital status . . . . .	-.07	.03	.0002
Risk . . . . .	.07	.03	.0004
Y intercept . . . . .	.28	...	...

<sup>1</sup> F = 65.86, P < .0001. R<sup>2</sup> = .30.

What is important about a multivariate inspection of the data is the opportunity it presents to weigh the relative importance of each variable independent of other known associations. From this exercise, we have learned that the most important predictors of women with the most recent Pap smears are the use of a variety of medical services and a pattern of illness behavior that is congruent with recommended medical practices. They are not the demographic variables which have been commonly used to predict use of Pap smear screening services.

Demographic variables are often used as proxy measures for factors which are more difficult to

identify, conceptualize, or measure. In other words, while age, education, and marital status are associated with Pap smear screening, the model suggests that the use of medical services and normative illness behavior are actually more helpful in predicting the recency of Pap smear screening.

A significant relationship between race and recency of Pap smear testing was not supported by these data. Probable explanations for this finding included the following:

1. The proportion of blacks in the sample was too small to detect any difference.
2. The relationship of race and Pap smear screening is related to specific generations and age cohorts. The dramatic changes in medical care accessibility, availability, and government insurance programs during the last 15 to 20 years have affected use of the Pap smear by removing financial barriers to services for poor populations.
3. The sampling frame excludes a disproportionate number of blacks, and those included are not representative of the entire black population. However, other population surveys have shown similar results with regard to race and cancer screening practices (14,19-21).

The implications of the results may be affected by a bias in sampling or in recall. Since older women, less educated women, and nonwhite women were underrepresented, and these women are also less likely to have Pap smears, these data may underestimate the predictive effect of these sociodemographic variables in the model. However these characteristics have also been associated with medical care variables, thereby having the potential to minimize their predictive effect.

Selective recall is a potential bias in any retrospective study. However, the Pap smear history was neither highly specific nor did it require remembering frequencies or dates from the distant past, and thus it minimized the potential for bias.

Several investigators have reported on programs for Pap smear screening that aim to take advantage of every medical contact by high-risk women (20-27). As a result of eliminating missed opportunities, the detection of cases increased; a shift from invasive to in situ cases was noted; and a decrease in mortality resulted. Celantano and colleagues studied cervical cancer cases and found that the women with cervical cancer had more missed opportunities than their controls. (27).

The implications of these studies on Pap smear

screening are several. First, any and all visits by women to a variety of medical services need to be considered opportunities for Pap smear screening. Second, regular patients and strong compliers of normative illness behavior will be most likely to be caught in the Pap smear screening network. However, those who see physicians as little as possible, and only under dire circumstances, are more difficult to catch in the network. Therefore, every effort must be made to turn these missed opportunities into screening opportunities. Howe and Bzduch (28) report that nearly one out of five women in their sample fell into this missed opportunity category. It is only with a concerted effort that we can hope to reduce the numbers of cases and deaths from invasive cancer of the cervix by increasing the numbers in the population who have recently had Pap smears.

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